COMPARISON OF DIFFERENT NUTRIENT MANAGEMENT IN HYDROPONIC AND FRESHWATER AQUAPONICS SYSTEMS: EFFECTS ON LETTUCE, MINT AND MUSHROOM PLANTS

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International conference “Aquaponics research mattes”
Ljubljana, 22-24 March 2016

INTRODUCTION

- Some nutrients from the aquaculture effluents are present in insufficient quantities for plants development
- In some cases nutrients ought be supplemented to the aquaponic system to ensure optimal performance of the plants
- However, the addition of fertilizers increases the managerial and economic effort
- ➔ Investigate the role of nutrients in order to optimize cost and management in the aquaponics production

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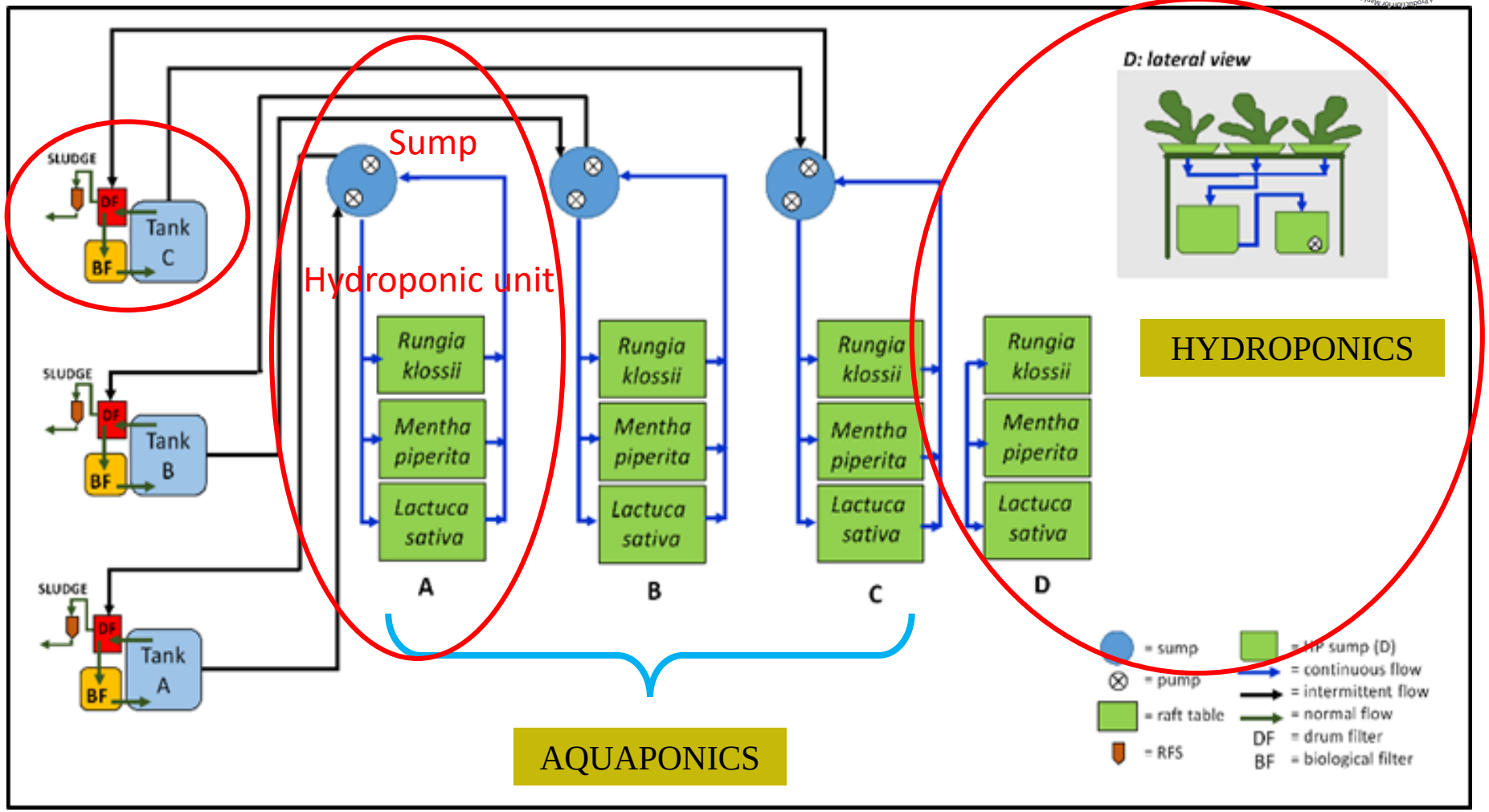
EXPERIMENTAL DESIGN-Systems

Aquaponics (3 systems):

- Fish tank
- Drum filter
- Biofilter
- solids thickening unit
- Hydroponic unit (3 tables, 1.2 m x 2 m each)
- Total water volume of each system: 4,400 L.

Hydroponics (1 reference):

- Hydroponic unit (3 tables, 1.2 m x 2 m each)
- Two sump (630L)

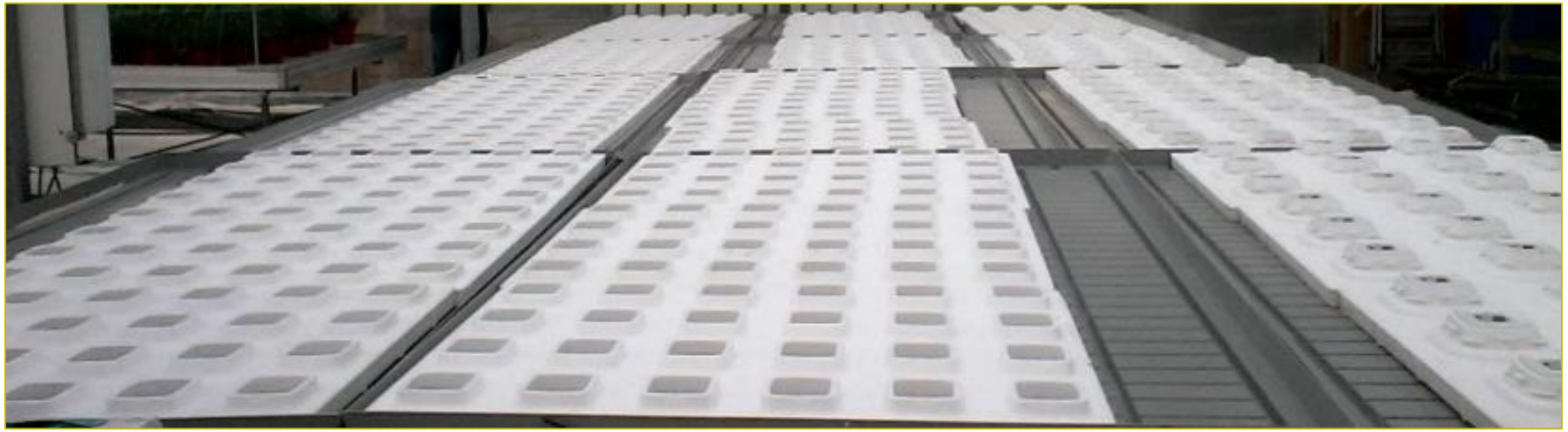


EXPERIMENTAL DESIGN-Species tested

72 mushroom herbs
(Rungia klossii)

72 mints
(Mentha piperita CHOCOLATE variety)

36 Lettuces
(Lactuca sativa YACHT variety (Salanova®))



50 Nile tilapia
(*Oreochromis niloticus)*

EXPERIMENTAL DESIGN-Nutrients regimes

Aquaponic

A

Nutrients derived solely from FISH FEED, no supplementation

Aquaponic

B

- Fish feed
- Micronutrient (Zn, B, Mg, Mo, Cu, Fe)
- Iron

Aquaponic

C

- Fish feed
- Micronutrient (Zn, B, Mg, Mo, Cu, Fe)
- Iron
- Macronutrients (P, K)

Hydroponic

D

HYDROPONIC SOLUTION:

- Micronutrient (Zn, B, Mg, Mo, Cu, Fe)
- Iron
- Macronutrient (P, K)
- Nitrogen (NO_3, NH_4)
- Ca

Nutrients, cost and management effort

EXPERIMENTAL DESIGN-Sampling

The experimentation ended when plants reached the commercial size, 4 weeks after the beginning

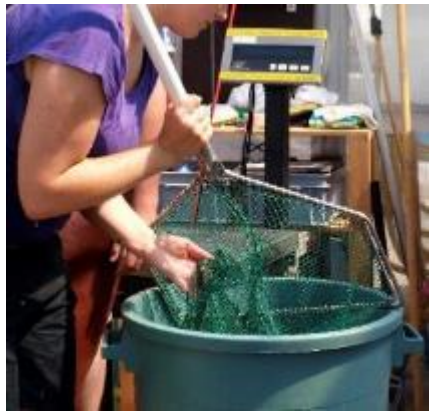
EXPERIMENTAL DESIGN-Analyses

PLANTS

- Total Biomass
- Fresh shoot weight
- Fresh root weight
- Root/shoot ratio
- Chlorophyll content (Chl)
- Epidermal UV-absorbance (Flv)
- Flavonols (Flv)
- Nitrate content
- Organic Matter
- CHN- elemental analysis

FISH

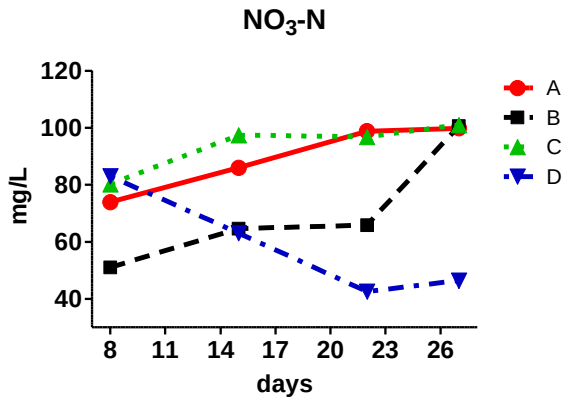
- Final biomass
- Specific growth rate
- feed conversion ratios

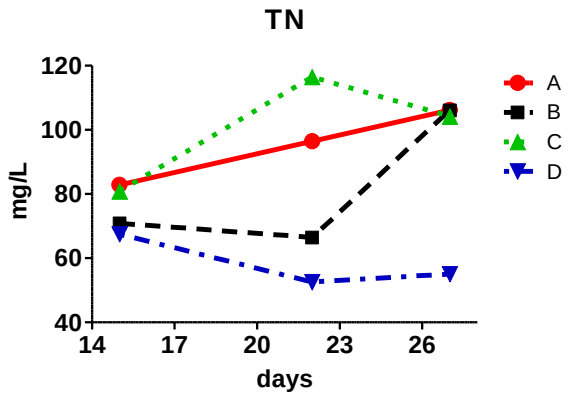


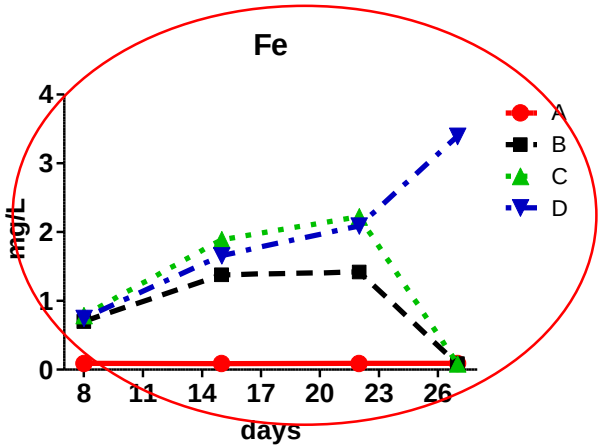
WATER

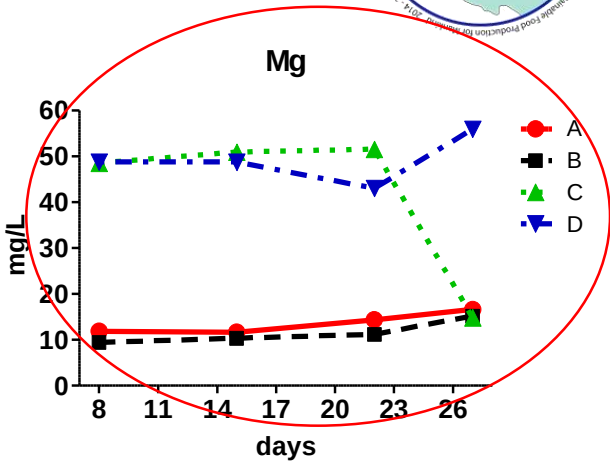
- NO_3-N
- TN
- PO_4-P
- K
- Fe
- Ca
- Mg
- °dH
- t°
- pH
- EC
- O_2

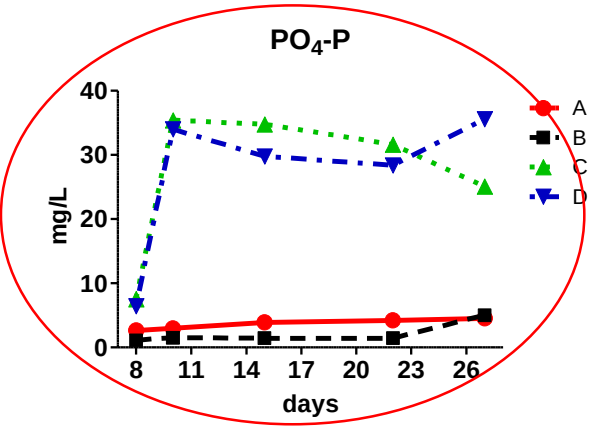
ANALYSIS ON WATER

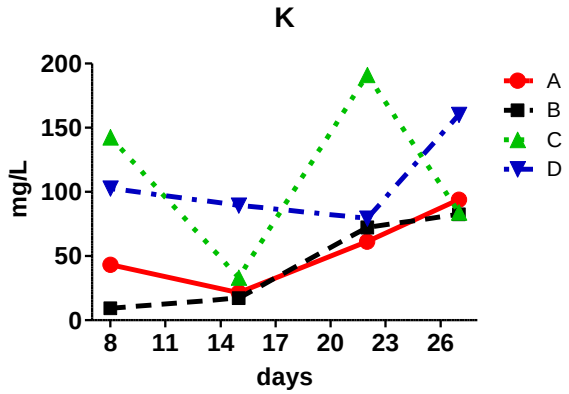


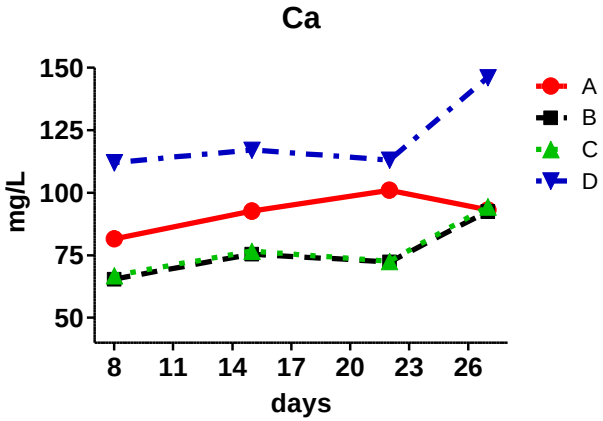


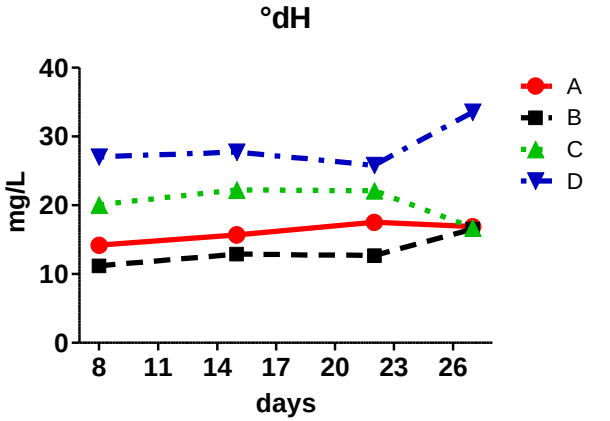












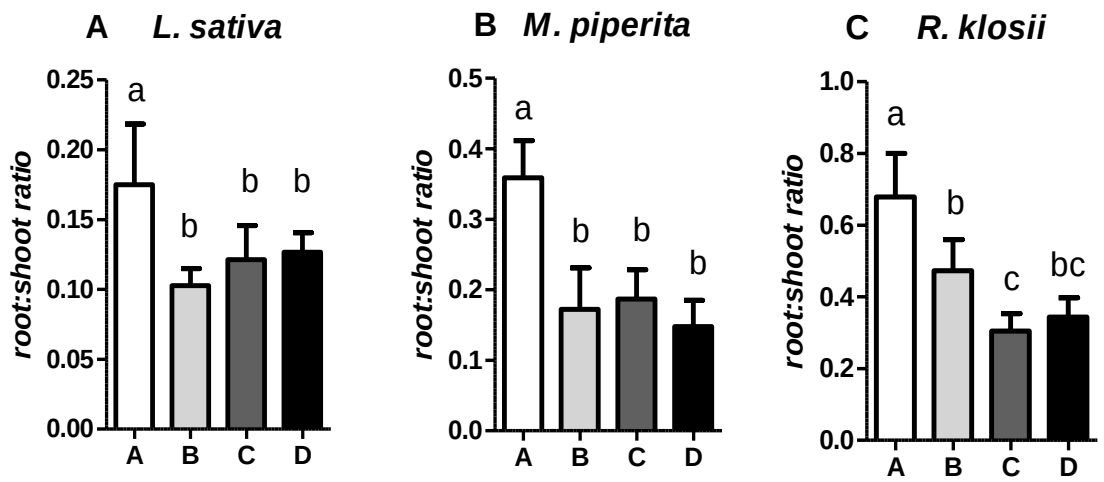
ANALYSIS OF FISH

Date / Duration	Parameters	Tank A	Tank B	Tank C
04.05.2015	Number of fish	50	50	50
	Total weight (kg)	12.4	10.8	11.3
	Average weight per fish (kg)	0.25	0.22	0.23
30.06.2015	Number	49	50	50
	Total weight (kg)	24.1	21.0	24.2
	Average weight per fish (kg)	0.49	0.42	0.48
57 days	Specific growth rate (%/d)	1.20	1.17	1.33
	Feed conversion ratio ($kg_{feed}/kg_{fish\ biomass}$)	1.25	1.49	1.16

ANALYSIS ON PLANTS

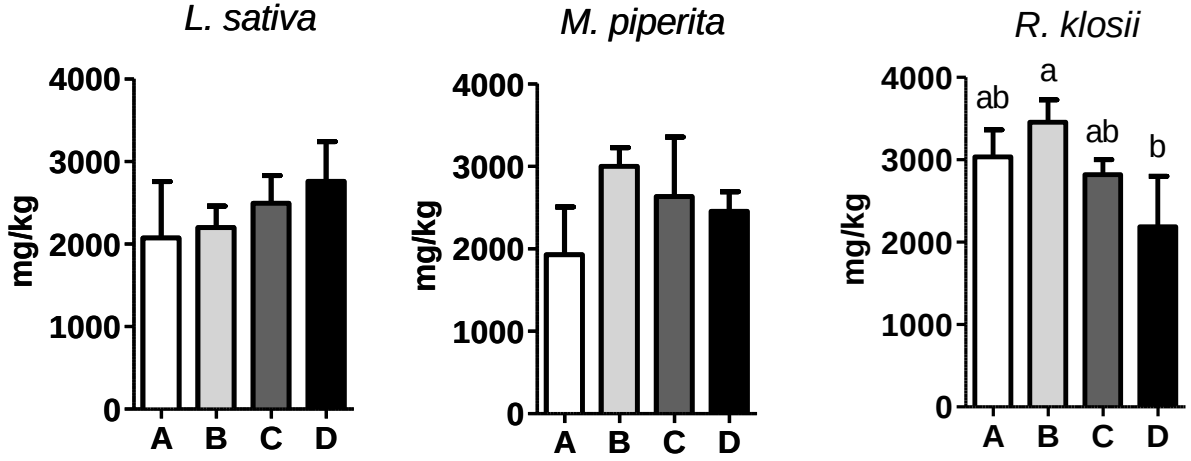
	Lactuca sativa				*Mentha piperita*				*Rungia klossii*			
	A	B	C	D	A	B	C	D	A	B	C	D
Total n. of plants	36	36	36	36	72	72	72	72	72	72	72	72
n. of no-saleable plants	1	/	/	/	6	/	/	/	/	/	/	/
n. of plants harvested	35	36	36	36	66	72	72	72	72	72	72	72
Total biomass (fresh) kg	9.2	10.6	13.5	12.4	7.7	11.6	10.5	9.9	1.31	1.25	0.76	0.98
Shoot (fresh) kg	8.0	9.8	12.3	11.3	5.7	9.5	9.0	8.7	0.67	0.66	0.43	0.53
Roots (fresh) kg	1.2	0.8	1.2	1.1	2.0	2.1	1.6	1.2	0.64	0.58	0.33	0.44
Average shoot weight g	222	272	341	314	79	132	124	120	9.3	9.2	6.0	7.4
Production (shoot) kg/m²	4.0	4.9	6.1	5.7	3.1	4.8	4.5	4.3	0.34	0.33	0.21	0.27

ANALYSIS OF PLANTS



ROOT/SHOOT RATIO

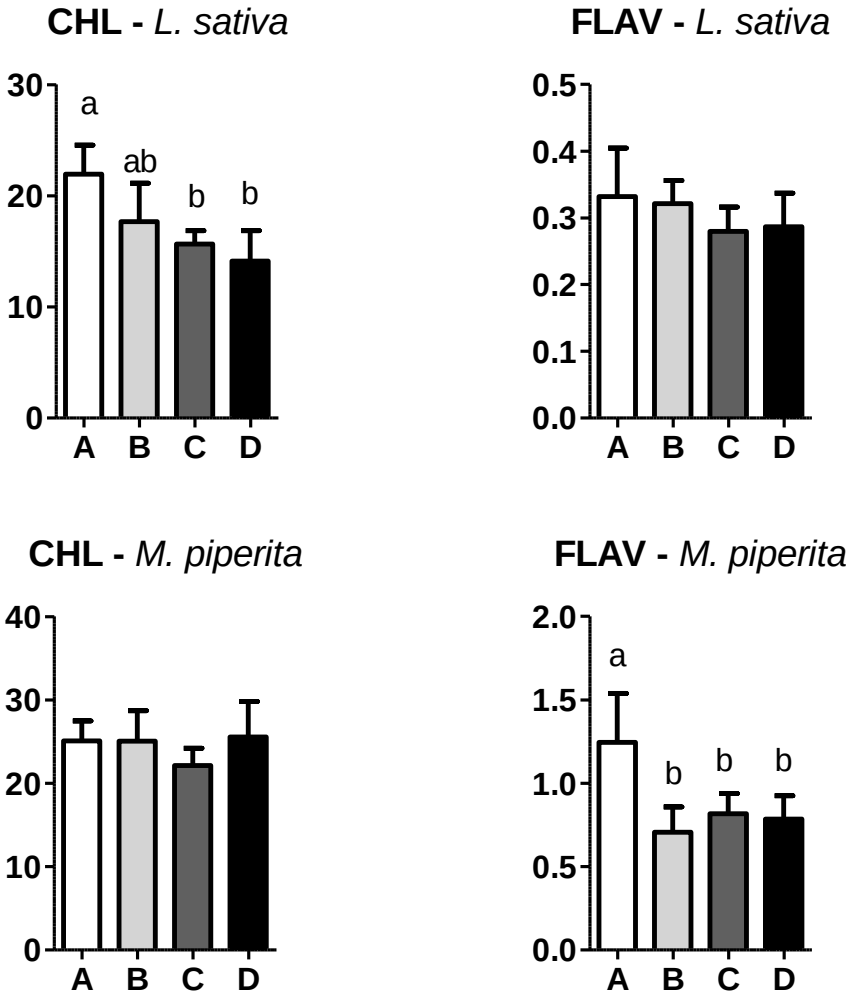
- Higher in system A respect to others groups in the three plant species
- Significantly higher in system B respect to C, in mushroom herb.



NITRATE IN LEAVES

- In lettuce, nitrate content was below the threshold value (3000 mg/Kg)
- Mints and mushroom plant are not subjected to nitrate legislation

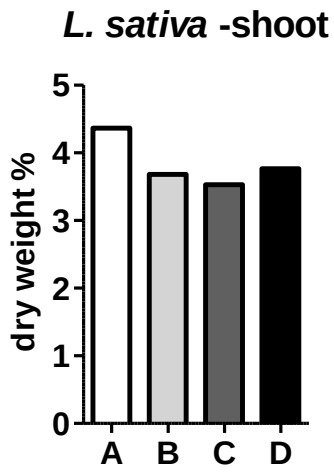
ANALYSIS OF PLANTS

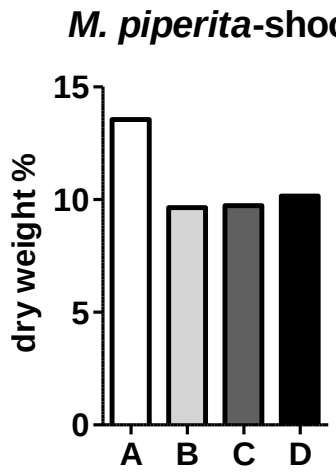


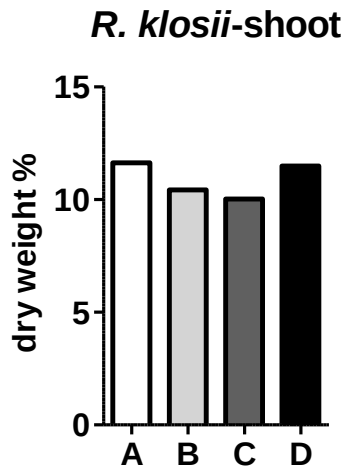
CHLOROPHYLL AND FLAVONOLS
(only in lettuce and mint)

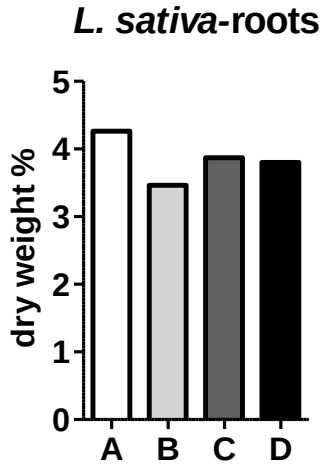
- Salads: Chlorophyll levels were highest in System A in respect to Systems C and D
- Mints: Flavonol levels were significantly higher in System A than in systems B, C and D.

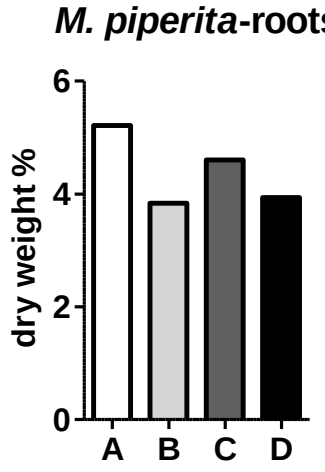
ANALYSIS ON PLANTS

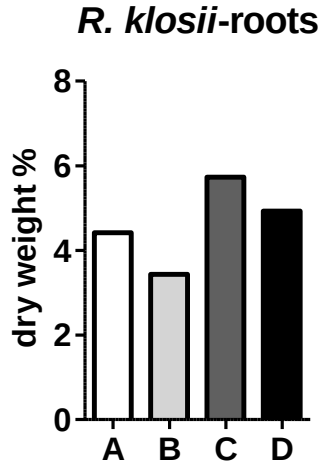








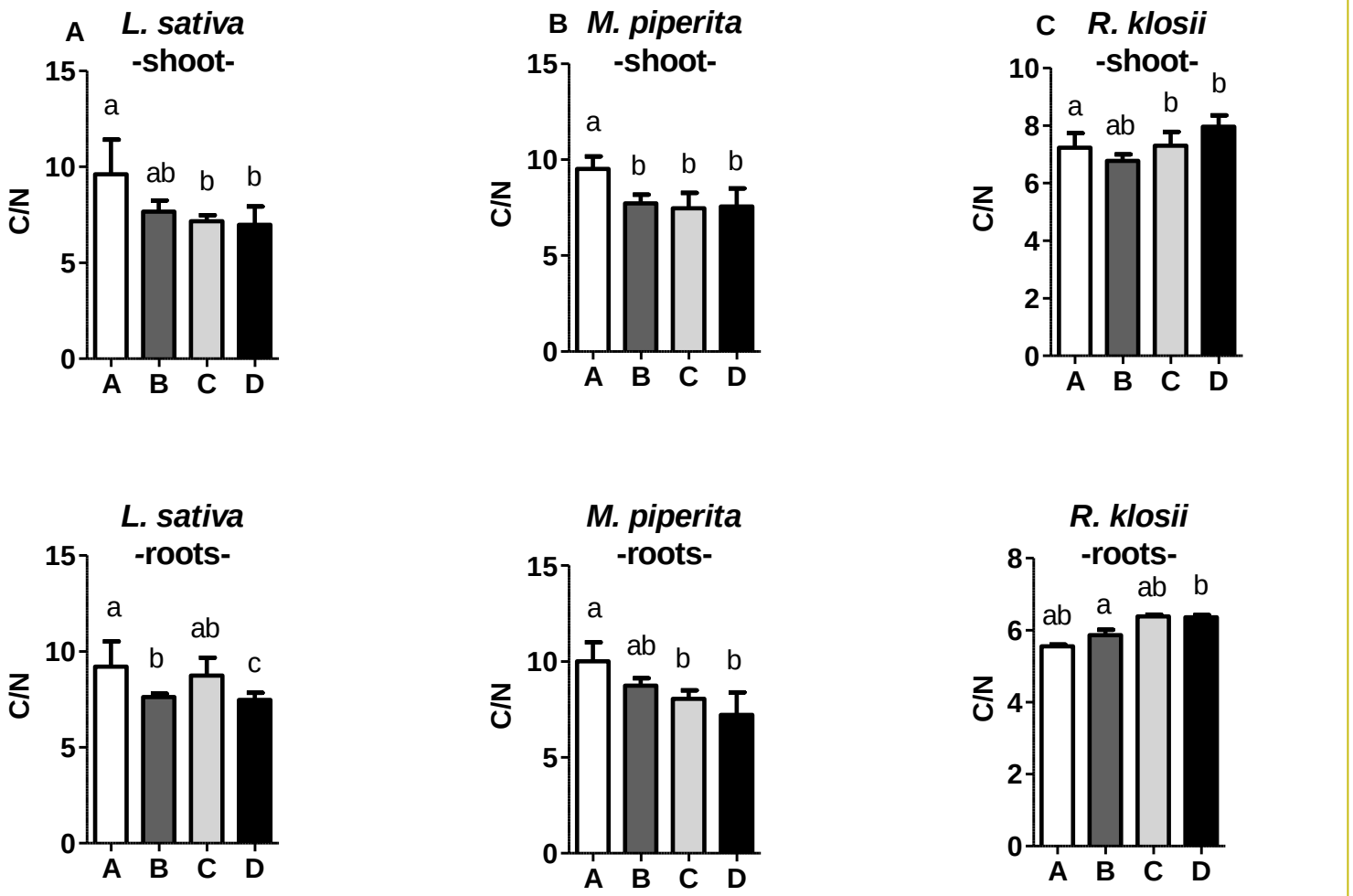




DRY MATTER CONTENT

- Lettuce and mint: higher dry matter content in system A both in shoots and roots.
- Mushroom herbs shoots: higher dry matter content in system A
- Mushroom herbs roots: highest dry matter content in system C

ANALYSIS OF PLANTS

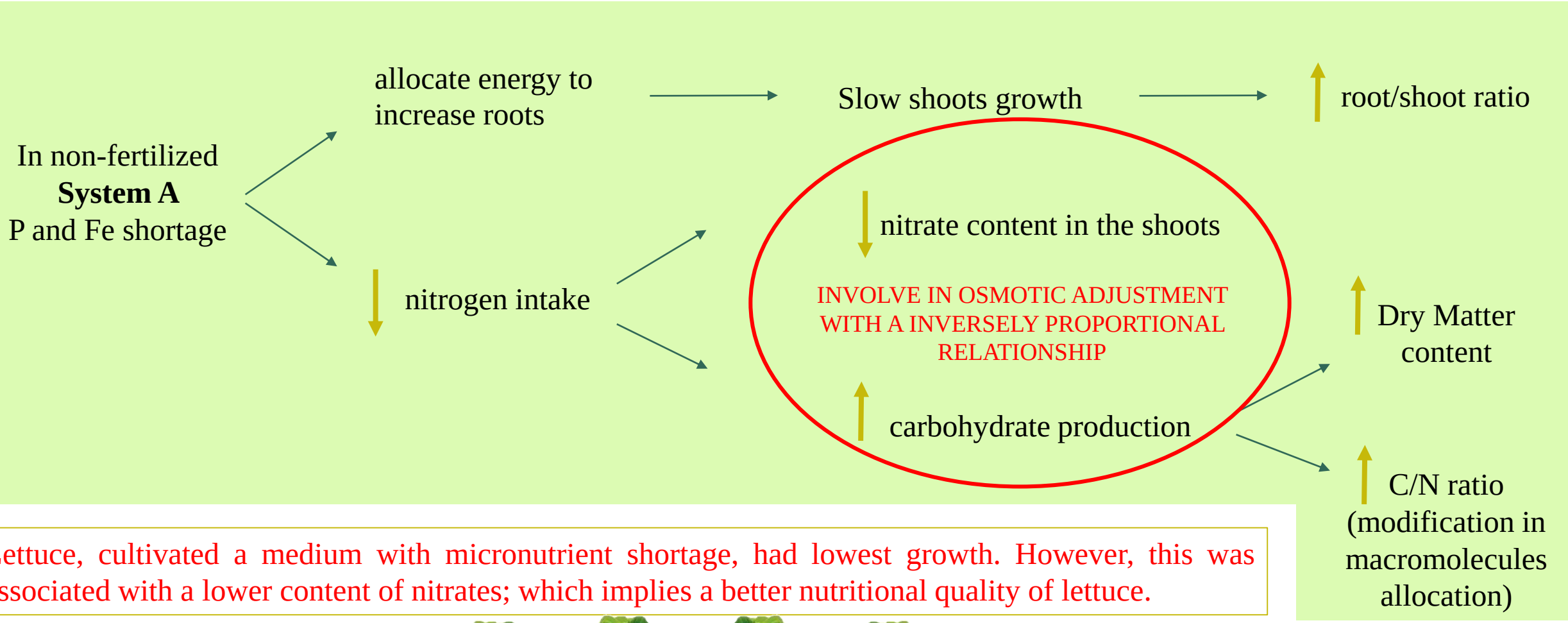


CARBON TO NITROGEN RATIO

- In the non-fertilized system A the C/N content of the biomass was higher as in systems B, C and D.
- Exception: mushroom herb

DISCUSSION

THE SHORTAGE OF MICRONUTRIENT INDUCED MODIFICATION IN LETTUCE GROWTH IN NON-FERTILIZED SYSTEM A



Lettuce, cultivated a medium with micronutrient shortage, had lowest growth. However, this was associated with a lower content of nitrates; which implies a better nutritional quality of lettuce.

DISCUSSION

PLANTS RESPONDED TO DIFFERENT NUTRIENT REGIMES ACCORDING TO THEIR NUTRITIONAL REQUIREMENT

LETTUCE > MINT > MUSHROOM HERB

- The nutrient supplementation improved the speed of growth in lettuce.

- Mints are susceptible to micronutrient limitation rather than to macronutrient deficiency.

- Mushroom herbs seem to be inhibited by high nutrient concentration

CONCLUSION

A HIGHER MANAGEMENT AND ECONOMIC EFFORT IS NOT ALWAYS RELATED TO AN OPTIMAL PLANT GROWTH AND QUALITY

In some cases the nutrient supplementation can result in a productivity inhibition (mint and mushroom herb)

The management effort is closely dependent on the plant species cultivated

IT IS PIVOTAL TO KNOWN THE NUTRITIONAL PLANTS REQUIREMENT IN ORDER TO OPTIMIZE COSTS AND USES OF FERTILIZERS IN AQUAPONICS

THANK YOU FOR YOUR ATTENTION